

Characterizing the Mauri of the Kaiwharawhara Catchment



Report Submitted to:

Dr. Nate Rigler

Dr. Terese McLeod

Zealandia Te Māra a Tāne

Submitted by:

Grant Kortfelt

Thomas O'Leary

Benjamin Petrich

John Sirois

Date:

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Chapter 1: Introduction

Water quality in any built environment is susceptible to aging infrastructure, negligence, and limitations in planning initiatives. Aotearoa New Zealand, a country with seismic activity and unstable terrain, faces added complications with monitoring its fragile ecosystem. Like many post-industrial nations, this has led to toxic runoff from sources such as decommissioned landfills, exacerbating the risk of impacting its water supply impacting the surrounding communities and local water sources. In the capital city Wellington, for example, the city has funneled over 90% of its streams through pipes to prevent flooding and erosion of inhabited land. While this protects the built environment, the ecosystem cannot access this water.

The Kaiwharawhara Stream is an exception to this trend and flows through the Greater Wellington area above ground. Research groups and environmentalists note the stream as highly important for supporting biodiversity, and many local species depend on the stream for survival. Despite its availability to wildlife, the stream is not considered safe. Two decommissioned landfills and multiple sewage leaks contaminate the Kaiwharawhara with toxic runoff, compromising the stream's health and threatening the surrounding landscape.

To make matters worse, the Kaiwharawhara catchment area lies within Zealandia Te Māra a Tāne (Zealandia), the world's first completely fenced ecosanctuary. This sanctuary is renowned for nurturing native birds in a space that is free of introduced pests. To that end, Zealandia has set a 500-year goal to restore its 225 hectares of land to pre-human conditions (*Zealandia > About*, n.d.). Zealandia's [Sanctuary to Sea](#) initiative strives to reduce the toxic runoff polluting the Kaiwharawhara and to restore the stream from its source to the sea. Purifying the Kaiwharawhara is a cornerstone of Zealandia's overall initiative, as the waterway already serves as a catalyst for species development and well-being throughout the bioregion.

A detailed understanding of the Kaiwharawhara Stream's contamination could allow Zealandia and its partners to better address this problem with actionable steps. Various researchers have collected data from the catchment area, but there has not been an opportunity to consolidate and map the information in a way that can promote policy initiatives. Quantifiable ecological health data as well as the cultural, social, and economic aspects of the catchment are critical for designing potential solutions.

The goal of this project is to partner with Zealandia Sanctuary to Sea to develop a framework for characterizing the overall health of the Kaiwharawhara catchment. To achieve this goal, the team has outlined three objectives: 1. To compile and map Zealandia's existing data trends and gaps in current research; 2. To identify and prioritize action items for the Kaiwharawhara catchment; 3. To develop and test a dashboard that can communicate our findings to partners in the Kaiwharawhara cleanup. The readily available data from the dashboard will facilitate Zealandia Sanctuary to Sea and its partners to develop an action plan for the catchment.

Chapter 2: Literature Review

This chapter details the setting of the project and highlights approaches that can inform data consolidation, visualization, and characterization for Zealandia Sanctuary to Sea.

2.1 Collaborating for water quality in Aotearoa

Poor water quality affects ecosystem species diversity, the health of communities, and the cultural identities of those who live in and share the watershed. Building a network that can share and optimize data can offer collaboration opportunities across agencies and interest groups to address critical resources. Within Aotearoa New Zealand, ecological health bears high cultural importance, and stakeholder collaboration addressing water quality issues provides a cultural touchstone that fosters social and cultural unity. Ecological restoration is also an important facet of long-term communion between humanity and the natural world. Internationally, decommissioned landfills have unfortunately continued to contaminate freshwater sources. A study in Gaeiras, Portugal discovered that landfill contaminants in the ground are regularly picked up and deposited downstream by flowing water sources such as rivers and stormwater runoff (Ramalho et al., 2013). Chronic problems regarding water quality and contamination are at the forefront of public concern (Heagney, 2024). Building research collaborations and promoting science communication can grow public awareness and support steps toward resolution.

2.2 Partners in ecosystem management

In Aotearoa New Zealand, cultural identity stemming from Māori values places paramount importance on the preservation of the personal connection between humanity and the natural world (Lockhart et al., 2019). Natural water sources are an integral part of the country's identity and well-being, a sentiment described as “Te Mana o te Wai,” or *water is life* (Clause 1.3, 2022). Residents and conservationists invested in the health of the land are striving to improve ecological health data and monitoring to consolidate information that can inform strategies for remediation.

Zealandia Sanctuary to Sea leads the Kia Mauriora te Kaiwharawhara initiative: a project with a 100-year vision for restoring the health of the Kaiwharawhara catchment (Zealandia, 2018). The scope of the catchment initiative is extensive, involving many partners sharing the effort to build momentum. Zealandia Wildlife Sanctuary and its staff are located at the head of

the Kaiwharawhara Stream. The sanctuary sits within the water catchment area and several branches of the Kaiwharawhara run through its protected land, as depicted below in Figure 2.1. Water contamination threats in this region could have dangerous consequences for its sensitive, biodiverse nursery and protected ecosystem. The mission to restore the sanctuary to pre-colonial Aotearoa includes regional watershed concerns.

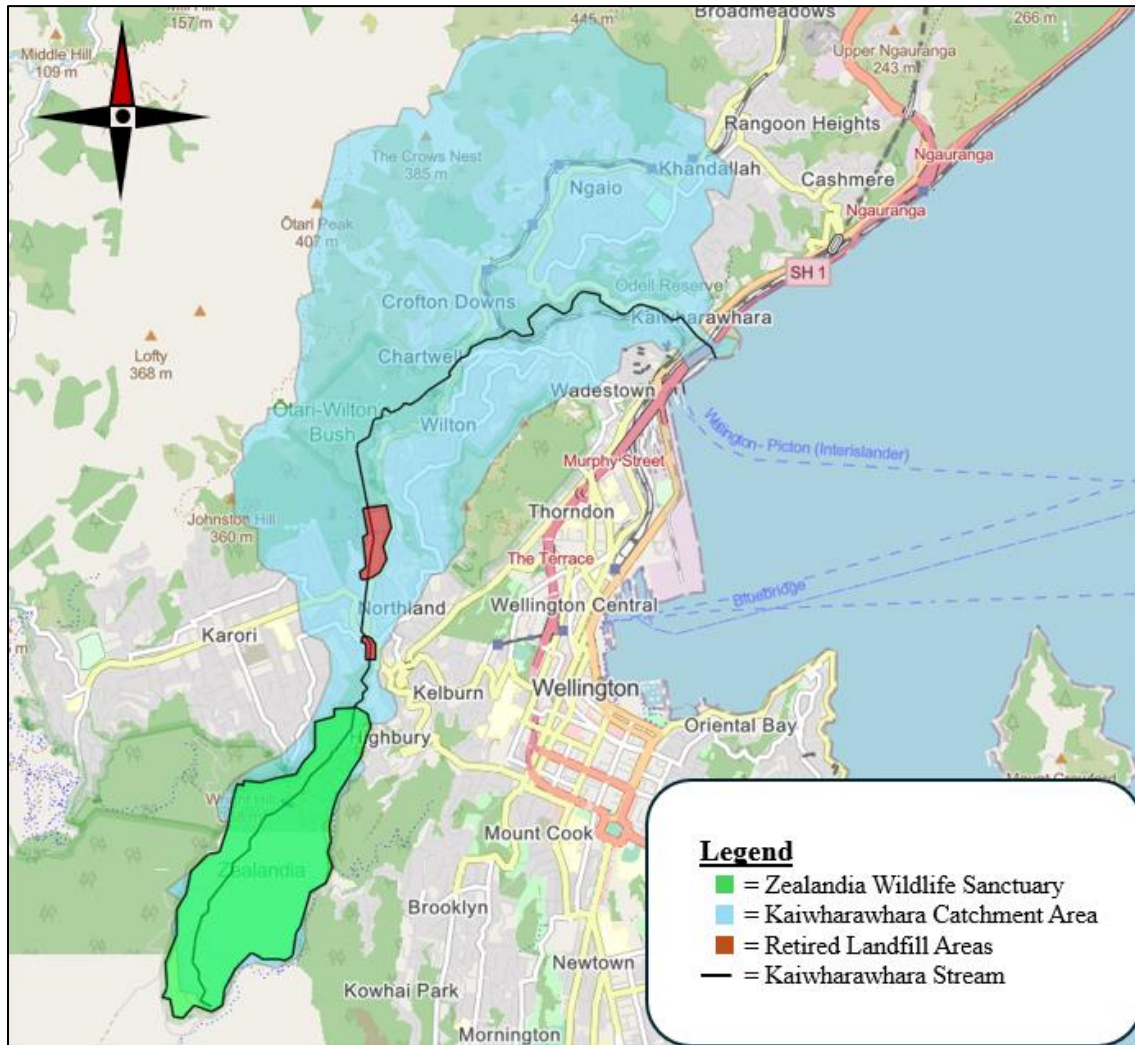


Figure 2.1: Map of the Wellington region, highlighting the location of the Kaiwharawhara catchment area and the retired landfills over which the Kaiwharawhara Stream flows (map credit: OpenStreetMap, modified by Grant Kortfelt with ArcGIS).

Three governmental agencies also have an interest in the project: the Department of Conservation (DOC), the Greater Wellington Regional Council (GWRC), and the local Wellington City Council (WCC). These civic groups each have some involvement with the Kaiwharawhara and the catchment area, and act as consultants for Sanctuary to Sea (Zealandia, 2018). Morphum Environmental is an environmental engineering consulting company with

expertise in catchment planning, water engineering, and sustainability that also supports the Sanctuary to Sea initiative (*New Zealand Engineering, Science, Geospatial & Sustainability Consultants*, n.d.). Wellington Water, the city water provider, maintains the piping infrastructure within Greater Wellington and is involved as a partner with the project (*Wellington Water*, n.d.). Wellington Water is also responsible for addressing and preventing sewage leaks within the catchment, and their website logs reports of contamination (Personal Communication: Nate Rigler, November 11, 2024). Morphum Environmental and Wellington Water are directly invested in the health of the Kaiwharawhara Stream and the water quality within the catchment, concerned with impacts both natural and urban (Zealandia, 2018).

Finally, numerous stakeholder groups operate within the Kaiwharawhara catchment. Among them are the Otari-Wilson's Bush trust and research scientists at Victoria University of Wellington. The Taranaki Whānui – the iwi (or Māori tribe) local to the Wellington Harbor area – have valued the cultural significance of the Kaiwharawhara for centuries (Zealandia, 2018).

2.3 How an aging infrastructure threatens water quality in Wellington

The Kaiwharawhara catchment area lies to the west of Wellington City and its tributaries flow northeast into Wellington Harbor. The catchment area (pictured below in Figure 2.2) includes several contamination sources, including decommissioned landfills and sewage leaks (Personal Communication: Nate Rigler, November 11, 2024).



Figure 2.2: The Kaiwharawhara catchment (used in perpetuity related to Zealandia Business. Any third party uses to be referred to and licensed by Rob Suisted).

Leachate in water runoff from these sources pollutes the Kaiwharawhara Stream as it collects and mobilizes the contaminants. The Kaiwharawhara catchment also hosts Zealandia Te Māra a Tāne, which protects native wildlife including kiwi, rodents, and birds from destructive non-native predators such as dogs, cats, and rats (Personal Communication: Nate Rigler, November 11, 2024).

As noted, the un-piped sections of the Kaiwharawhara are critical for the support of complex and diverse biological interaction. This is the only stream in the Greater Wellington region that flows into Wellington Harbor (see Figure 2.3), and its many diadromous fish species rely on both freshwater and saltwater for their reproductive cycle (Personal Communication: Nate Rigler November 11, 2024).



Figure 2.3: Wellington City and Wellington Harbor pictured from the hillsides of Oriental Bay (image credit: Ulrich Lange via Wikimedia Commons).

Ongoing contamination of this stream poses major risks to the region's ecological health and upends Zealandia's goal of *kia mauriora*, or the enhancement of the region's health and biodiversity (Personal Communication: Nate Rigler, November 11, 2024).

The contamination poses a known threat to residents who interact with the water. Minor scrapes or cuts sustained during play on the local sports field located above one of the nearby decommissioned landfills often lead to infection. Interaction with the water itself, which once posed no risk to swimmers in the stream, now also presents the risk of toxic exposure.

2.4 Ecological health monitoring for decision-making

In recent decades, routine ecological health monitoring has been a positive contribution as experts realize regular collection and processing of data holds high importance (Burt et al., 2014). Long-term data reveal patterns, trends, and cycles, and can document infrequent events, allowing experts to develop mitigation and adaptation strategies (Burt et al., 2014). Many countries, including Aotearoa New Zealand, have implemented monitoring programs to support decision-making regarding the protection of the natural environment (Behmel et al., 2016).

The parameters and indices to determine water quality generally include physicochemical properties, hydromorphological status, biological composition, and chemical composition (Madrid & Zayas, 2007). Monitoring these parameters to assess the overall water quality is one feasible and efficient way to gauge an area's health (Bhardwaj et al., 2018). Other measurable ecological components that measure wellbeing include the abundance of nutrients, invasive species, land use, land cover, and human impact (Mamun & An, 2022). Monitoring quantifiable

ecological health data is crucial to providing stakeholders and experts with information to make informed decisions for improvement.

2.5 Evaluating the holistic well-being of a natural environment

In 2006, a team of Māori researchers created a method for quantifying and evaluating the *mauri* or life force of a place known as the Mauri Model Decision-Making Framework (MMDMF). While the framework is nearly two decades old, the author revisited the model in 2018 and Taute et al. applied it recently in 2023 (Morgan & Fa`aui, 2018; Taute et al., 2023). While often described as the overall life force, the MMDMF defines *mauri* using four dimensions: the *mauri* of ecosystem (environmental wellbeing), hapū / iwi (cultural wellbeing), community (social wellbeing), and whānau (economic wellbeing) (Morgan & Fa`aui, 2018). Each of these four dimensions possess different indicators. Pertaining to the ecosystem are indicators such as forest density, biodiversity, and water quality. The cultural dimension includes the prevalence of traditional Māori practices involved with the area and the area's significance to the local Māori community. The social interactions within the area pertain to the *mauri* of community. Finally, the local economic situation, businesses within the area, and commerce relating to the region relate to the economic dimension (Morgan & Fa`aui, 2018). Appendix B presents a complete list of these dimensions and their indicators.

While *mauri* encompasses quantifiable sub-categories, the overall well-being is not equivalent to the sum of its parts. The interconnectedness of the different aspects of the catchment is essential to the *mauri* strength. The well-being of the dimensions alone is not sufficient; the interaction must also thrive or the collective *mauri* will suffer (Michel et al., 2019; Taute et al., 2023). Furthermore, *mauri* is not defined by a moment in time; it is longitudinal. The interactions of ancestors and descendants with the environment will factor into the overall *mauri*. Hence, Māori must connect with their natural environment as their ancestors did, and nurture future relationships with their surroundings (Taute et al., 2023).

To quantify *mauri*, the MMDMF uses a subjective yet structured rating system for each dimensional indicator, scaling from -3 to 3. Each overall dimension value is the average of its indicators. The framework then calls for a pairwise comparison of dimensions to determine their relative importances (Morgan & Fa`aui, 2018). The MMDMF design accounts for the value that stakeholders place on each dimension of *mauri* (Morgan & Fa`aui, 2018). A modification of this framework (detailed in Section 3.2) can produce a preliminary method to evaluate and quantify

the overall mauri health. This quantification of mauri will be crucial in characterizing the catchment area of the Kaiwharawhara.

2.6 Granting personhood to the environment for protection

Policymakers often implement externally designed ‘top-down’ approaches toward water management strategies that lack important input from community members (Talbot-Jones & Bennett, 2022). In contrast, ‘bottom-up’ approaches use social norms, customs, beliefs, and traditions to enhance institutional effectiveness for managing water resources (Talbot-Jones & Bennett, 2022). Granting personhood to water bodies is a relatively new legal tool that addresses issues associated with inefficient top-down management. Lawmakers have implemented the personhood approach on the Whanganui River in Aotearoa New Zealand, the Rio Atrato in Colombia, and others worldwide.

The ‘Rights of Nature’ approach advocates for granting legal rights to natural objects and ecosystems for protection (Talbot-Jones & Bennett, 2019). In short, the government considers the natural object as a person with lawful rights to self-determination. The approach suggests that groups responsible for discrimination or injury toward the protected entity must invest in relief efforts to resolve this past neglect (Talbot-Jones & Bennett, 2019). ‘Rights of Nature’ aligns with Māori identity as kaitiaki (guardians) of land, soil, and water as taonga (treasures) and provides a sense of unity among iwi (*Māori and the Land*, n.d.).

2.7 Visualizing data for shared learning

Moving the data points from the mauri indicators into actionable policy is a lesson in science communication. Without expert consolidation and visualization, there are severe limitations regarding the application of collected data. While the Zealandia Sanctuary to Sea partners have a wealth of data on the Kaiwharawhara catchment, there is an opportunity to improve how scientists and researchers interact with these data and the public.

Expressing these data can facilitate the ease and quality of its analysis and ultimately enable the initiative partners to make better-informed decisions. There are many ways to develop a platform for amplifying the findings, but a dashboard format can allow multiple users to visualize and share data quickly and effectively. An analytical dashboard can serve as a source and archive that provides methods for identifying patterns, gaining insights, or drawing conclusions (Ustun, 2024). Relating to the Kaiwharawhara initiative, a visualization tool could

synthesize data to easily assess and communicate environmental mauri, water quality, and biodiversity.

2.8 Critical findings to inform upcoming work

A comprehensive review of available literature revealed key points that will inform our study going forward. The Greater Wellington region is a culturally rich area that has capacity for supporting ecological restoration, including the decontamination of the Kaiwharawhara watershed. Indices that can measure and characterize the mauri and wellbeing, are essential tools for ecological analysis and cultural interaction. However, for data emerging from these research efforts to be used to catalyze action, they must be shared and widely communicated. Dashboards are one example of a useful platform for visualizing data and fostering awareness and communication within local communities.

Chapter 3: Methodology

The goal of this project is to partner with Zealandia Sanctuary to Sea to develop a framework for characterizing the mauri of the Kaiwharawhara catchment. We have identified three objectives to achieve this goal:

1. Compile and map Zealandia’s existing data trends and gaps in current research.
2. Identify and prioritize action items for the Kaiwharawhara catchment.
3. Develop and test a dashboard that can communicate our findings to partners in the Kaiwharawhara cleanup.

This chapter details our various methodologies and strategies to meet our objectives and achieve the project goal. Figure 3.1 illustrates the connection between these components of this project.

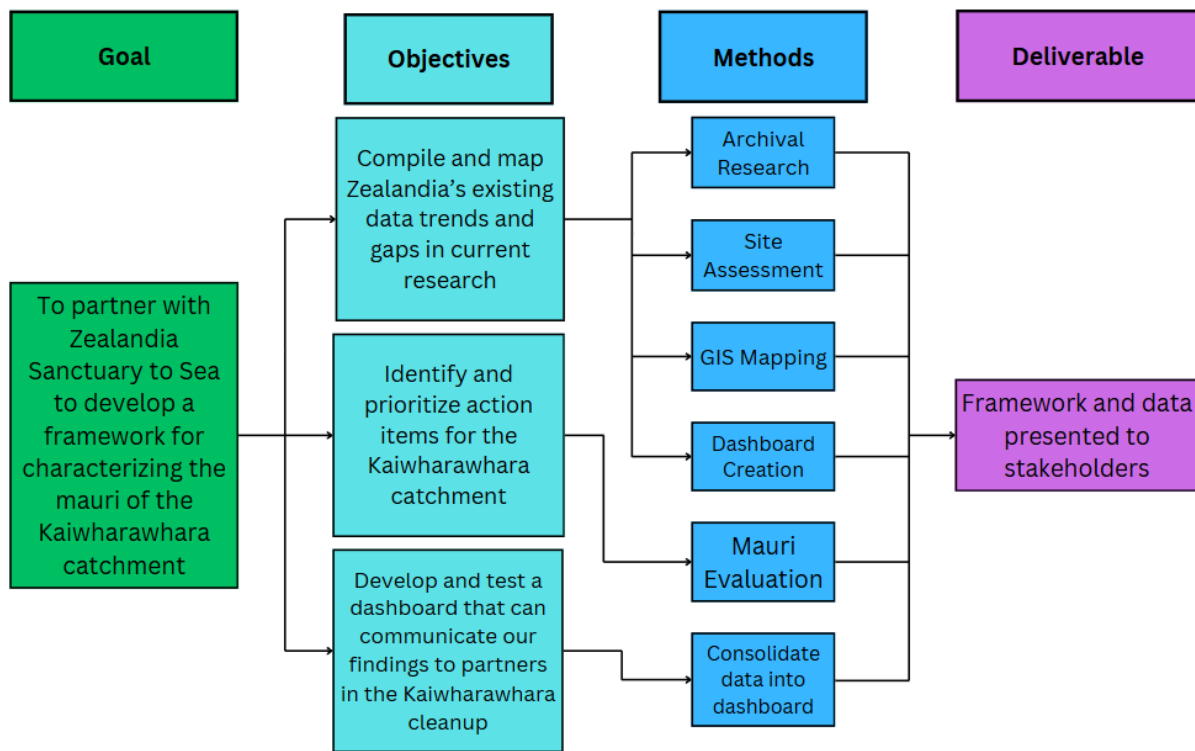


Figure 3.1: Methods diagram, depicting the goal, objectives, methods, and deliverable.

3.1 Compile and map existing data trends and gaps in current research

Conducting a site assessment

Upon arrival, our project sponsor Dr. Nate Rigler will lead us on a site inspection of the Kaiwharawhara catchment. To help categorize the catchment, the team will develop a standardized site assessment survey (see Appendix A) to analyze locations that our sponsor deems notable, including landfills and sewage leaks. This survey will include sections to detail descriptions of each point of interest and a discussion of the visual, historical, and cultural attributes. Dr. Rigler will review and provide feedback on this survey before we spend the first few days touring the region.

Organizing Zealandia's archives

Zealandia Sanctuary to Sea's online archive contains documents for various surveys and studies of the Kaiwharawhara catchment. However, their team has not had the chance to organize this data, hindering proper analysis of issues regarding the catchment. Our team will interact with Zealandia's scientists to consolidate their archives and sort documents based on several simple metrics such as the type of data they contain, their sources, the date of the study, and document sensitivity. The team will further sift through their considerable raw data to single out documents that hold potential value to the watershed project (Ward, 2014). This effort is designed to provide us and Zealandia Sanctuary to Sea with a well-synthesized foundation for populating a database platform.

GIS mapping to visualize the catchment

Geographic information systems (GIS) provide a means to consolidate and visualize geographic data in various ways (Ward, 2014). Because mapping the catchment area is critical for visualizing the mauri of the region, our team plans to use GIS to characterize the Kaiwharawhara stream. The characterization includes its surrounding vegetation, distribution of urban settlements within the catchment, and contaminant locations. Historically, researchers have applied GIS to "a variety of urban functions" including urban and transportation planning, public service delivery, and disaster response (Ward, 2014, pg. 119). This tool possesses an extensive scope of applications and will assist our team in logging each site's distinctive traits.

Team members Grant Kortfelt and John Sirois will head the project's ArcGIS mapping using the free software package to create overlay polygons and ArcGIS StoryMaps that display

critical regions like Zealandia Sanctuary, the Kaiwharawhara stream, and decommissioned landfills. Grant and John will also input photos and data gathered during the site assessment and map them to their corresponding locations. They will save these maps locally to allow our partners to access and edit them after we conclude our project work. Terese McLeod and Dr. Nate Rigler will act as consultants for navigating Māori concerns and the future availability and accessibility of these maps.

3.2 Identify and prioritize action items for the Kaiwharawhara catchment

Mauri evaluation index model (MEIM)

To draw conclusions about the Kaiwharawhara catchment health and wellbeing, we will adapt a mauri evaluation index model (MEIM) based on the Mauri Model Decision-Making Framework (MMDMF). From the discussion in Section 2.5, the MMDMF divides mauri into four dimensions (environmental, cultural, social, and economic), and each dimension has sub-dimensions called indicators (listed in Appendix B). A health score between -3 and 3 quantifies each indicator. We will construct a preliminary model to compute each dimension score based on a weighted average of these indicators.

Interviews with experts and scientists

On site, our team will review the preliminary model with our partners from Zealandia and others with experience using Māori assessment indicators. Team members Benjamin Petrich and John Sirois will interview local experts on mauri, specifically Sara Belcher from Victoria University, whose work includes cultural indicators within a Māori context (see Appendix C for consent forms; see Appendix E for a list of discussion points). An open-ended discussion with her and with other experts will help us fine-tune the indicator weights in our model and maximize its effectiveness. The improved MEIM framework will allow us to score each of Zealandia's datasets, contributing to a determination of catchment action items.

3.3 Develop and test a dashboard to communicate findings to partners

Data consolidation into the platform

To consolidate, organize, and standardize Zealandia's data, we will construct a dashboard for data visualization and analysis. The data encompasses water quality, contamination sources, ecological surveys, and sewage leaks. Our team plans on utilizing JavaScript to create this dashboard and will host it on a website we design for easy and reliable access. The plan is to

store the data in an SQL database and design graphs and tables with JavaScript visualization libraries. The dashboard will enable the user to set display preferences with parameters such as data timeframe and data type. Since some data is sensitive, Zealandia employees and members of the local iwi will determine the extent of its distribution. The dashboard will provide key metrics from Zealandia's data archive that are easy to find and analyze.

User testing and interviews

After reviewing the dashboard with our project advisors and Zealandia liaisons, Thomas O'Leary and Grant Kortfelt will conduct dashboard user testing with its intended users. The focus will be on testing the dashboards' interactivity, user-friendliness, intuitive design, and visual appeal. We will structure these product testing sessions as an open-ended interview with user consent. Our interviewees will trial the dashboard on their own time, then we will discuss their user experience with them, per Appendix D and Appendix F. An improvement of the dashboard based on feedback will follow. These revisions will be a critical step in our development of the dashboard.

Develop findings for communication

The dashboard is meant to simplify the communication of data findings to the local tribal authority. To test the efficacy and launch of our platform, we will present at a meeting run by Zealandia Sanctuary to Sea. We plan to share a written report and present a slideshow summarizing the critical results and visuals. The report will include information about our dashboard and mauri evaluation index model. We intend our findings to be a pilot for their ongoing project to grant personhood to the Kaiwharawhara Stream. Additionally, our team will complete a final written report concluding our project. It will include complete information on our dashboard, usage of the MEIM, and supplemental findings. It will be sent to the local iwi, Zealandia, and our university.

3.4 Proposed timeline

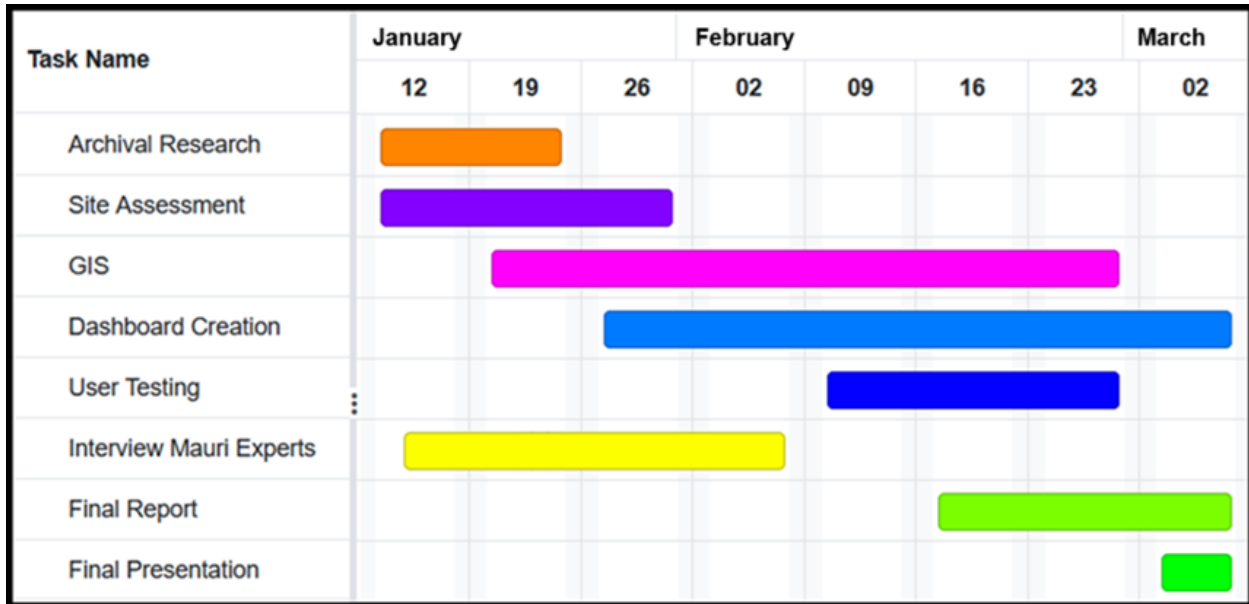


Figure 3.2: Proposed timeline for our project work.

Chapter 4: Conclusion

This project is significant because the Kaiwharawhara Stream holds cultural importance and ecological importance to life in the catchment. These contributions to environmental health align with United Nations Sustainability Goals such as ‘Good Health and Well-Being’, ‘Clean Water and Sanitation’, ‘Life Below Water’, and ‘Life on Land.’ (*THE 17 GOALS / Sustainable Development, 2015*). Our research hopes to showcase the severity of this problem, provide metrics for quantifying the mauri of the area, and provide user-friendly data visualization techniques. The consolidation of data is a critical step in science communication, allowing for easy access and analysis of the catchment and support of the Kaiwharawhara personhood project. These efforts will benefit those working to clean and protect the Kaiwharawhara catchment area and its biodiversity. We are looking forward to working with Zealandia Sanctuary to Sea on this project.

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Appendix A: Site Assessment Survey

Team Members Present _____

Site Name _____ Site Coordinates _____

Photography? Y / N

Google Maps Pin? Y / N

Has the location been tested before? Y / N If yes, describe: _____

Can we conduct tests at the location now? Y / N If no, explain: _____

Relevant mauri components:

Ecosystem / environmental: _____

Hapū / cultural: _____

Community / social: _____

Whānau / economic: _____

Site description: _____

Stakeholders: _____

Positives: _____

Negatives: _____

Appendix B: Mauri dimension indicators

Environmental mauri

- Water quality
- Animal health and diversity
- Plant health and diversity

Cultural mauri

- Traditional Māori practices involving the catchment
- Catchment's significance to the Māori: past, present, and future

Social mauri

- Community involvement with the catchment
- Local work done to improve the catchment

Economic mauri

- Local businesses
- Local economic situation

Appendix C: Consent Form – Mauri Experts Interview

Who we are: We are a team of American college students working with Zealandia Sanctuary to Sea to develop a framework for characterizing the mauri of the Kaiwharawhara catchment.

Purpose of this interview: Your experience and knowledge will help us improve our understanding of mauri and our model that quantifies it.

Procedure of this interview: We will ask a series of questions about mauri and general wellbeing of an area along with its quantification. This interview will be semi-structured and discussion oriented. Furthermore, you may skip any questions you do not wish to answer.

Confidentiality: We will not publish any details about your identity in this project without your permission.

However, if you wish to share any details about yourself in publication (i.e. name and/or university/employer), please share below:

Thank you for your time!

Appendix D: Consent Form – Dashboard Testing

Who we are: We are a team of American college students working with Zealandia Sanctuary to Sea to develop a framework for characterizing the mauri of the Kaiwharawhara catchment.

Purpose of this testing: Your feedback will help us improve the dashboard visually and functionally.

Procedure of this testing: We will ask you to use our dashboard and then we will ask you to share your opinions on the experience and functionality of the dashboard. Your participation in this research is voluntary. Furthermore, you may skip any questions you do not wish to answer.

Confidentiality: We will not publish any details about your identity in this project.

Thank you for your time!

Appendix E: Interview Topics – Mauri Experts

As discussed in Section 3.2, we will conduct open-ended interviews with mauri experts. Here is a list of questions which we would like to ask:

- E.1 What is your background with respect to Māori culture?
- E.2 What is your background with respect to mauri / ecological or cultural wellbeing?
- E.3 How would you describe the interconnectedness of mauri?
- E.4 What sub-components of mauri do you think are most important?
- E.5 Is there any nuance within the area that we would not know about?
- E.6 Is there anything else you would like to tell us?
- E.7 Are there any other people you know that would be willing and helpful to interview?
- E.8 What would it take to bring this project to fruition?

Furthermore, here is a list of topics we would like to discuss:

- E.9 Our Mauri Evaluation Index Model
- E.10 The types of data we have and its coverage
 - E.10.1 What does the interviewee think is best to study next?
- E.11 Specific issues within the Kaiwharawhara catchment that we will learn about in our site assessment
 - E.11.1 What is the relative importance of each issue to the interviewee?

Appendix F: Interview Topics – Dashboard Tester

As discussed in Section 3.3, we will trial our dashboard with potential users. Here is a list of questions the users will answer:

- F.1 Generally, how was the experience?
- F.2 What parts of the dashboard are most visually appealing?
- F.3 What parts of the dashboard are most easy to navigate?
- F.4 What visuals were your favorite?
- F.5 What visuals need improvement?
- F.6 Are there any charts or visuals you think would be helpful to add?
- F.7 Is there anything else you would like to tell us?
- F.8 Are there any other people you know that would be willing to test the dashboard?
- F.9 What would it take to make this dashboard a success?